SECTION 26 3353

STATIC UNINTERRUPTIBLE POWER SUPPLY

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LANL MASTER SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the ESM Electrical POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within “stars” during editing.

Specification developed for ML-3 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

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PART 1 GENERAL

1.1 SECTION INCLUDES

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Edit the following articles to match project requirements.

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A. Section covers static double-conversion three-phase uninterruptible power system(s) (UPS), rated 15 kVA and greater, to provide continuous ac power to critical loads and/or to improve the quality of ac power to critical loads.

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 3300, Submittal Procedures:

1. Calculations:

a. Submit battery sizing calculations per IEEE Std 1184 Guide for Batteries for Uninterruptible Power Systems.

b. Submit UPS selection calculations indicating de-rating for altitude and ambient temperature per IEC 62040-3 Uninterruptible Power Systems (UPS) - Part 3: Method of Specifying the Performance and Test Requirements.

c. Submit coordination study for UPS prepared in accordance with IEEE Std 242 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; demonstrate fully selective coordination with immediate upstream and downstream overcurrent protective devices.

2. Catalog Data: Submit manufacturer's descriptive and technical literature describing each type UPS, battery, accessory item, and component specified. Include data substantiating that materials comply with specified requirements.

3. Certification: Submit certification and backup information that UPS can perform required functions after a design earthquake as specified in "SERVICE CONDITIONS" below.

    a. UPS designated with I_p greater than 1.0 shall be certified by the manufacturer to withstand the total lateral seismic force and seismic relative displacements specified in the International Building Code (IBC) or ASCE 7, Minimum Design Loads for Buildings and Other Structures.

    b. Manufacturer's certification shall be based on shake table testing or experience data (i.e., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety.

    c. Required response spectra shall exceed 1.1 times the in-structure spectra determined in accordance with IBC AC156, Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

4. Certification: Submit certification by manufacturer's field technical representative that the contractor has installed, adjusted, and tested the UPS according to the manufacturer's recommendations.

5. Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified in "Quality Assurance". Include instructions for storage, handling, protection, examination, installation, and starting of Product, including equipment anchoring requirements to meet the seismic conditions specified in "SERVICE CONDITIONS".

6. Operation and Maintenance Instructions:

    a. Submit complete operation and maintenance instructions including step-by-step start-up, operating, shutdown, inspection, and maintenance procedures.

    b. Include the manufacturer's name, equipment model number, service manual, parts list, and brief description of equipment and its basic operational features.

    c. Include possible breakdowns and repairs, troubleshooting guides, the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment.

d. Provide spare parts data for each different item of material and equipment specified, not later than the date of beneficial occupancy. The data shall include a complete list of parts and supplies with current unit prices and source of supply and an itemized price breakdown of spare parts recommended for stocking. The recommended spare parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.

e. Submit lesson plans and training manuals for the training phases, including type of training to be provided and proposed dates, with a list of reference materials.

7. Shop Drawings: Submit shop drawings for each UPS including dimensioned installation plans and elevations based on field measurements. Include front and side views of enclosure showing overall dimensions, enclosure type, enclosure finish, unit locations, conduit entrances, and details required to demonstrate that the system has been coordinated and will function properly as a unit. Include the following:

a. Front, side, and plan view of the UPSs.

b. Single line or three line diagrams.

c. Nameplate schedule.

d. Component lists.

e. Conduit entry locations.

f. UPS ratings including short circuit, voltage, and current.

g. Major component ratings including voltage, current, and interrupting.

h. Cable terminal sizes and types.

i. Shipping splits.

j. Bus configuration and current ratings.

k. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

8. Test Reports: Submit results of factory production tests specified in NEMA PE 1, Uninterruptible Power Systems, additional factory tests required by this Section, and field tests required by this Section.

a. Submit detailed description of proposed factory test and field test procedures, including proposed dates and steps outlining each test,

how it is to be performed, what it accomplishes, and its duration, not later than 2 months prior to the date of each test.

b. Submit factory and field test reports in booklet form tabulating factory and field tests and measurements performed, upon completion and testing of the installed system. Factory and field test reports shall be signed by an official authorized to certify on behalf of the manufacturer of the UPS that the system meets specified requirements. The reports shall state the Contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

9. Wiring Diagrams: Submit detailed schematic wiring diagrams including device identifications and numbered terminals for power, control, communications and instrumentation systems, and differentiating between manufacturer-installed and field-installed wiring.

1.3 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in this Section are as defined in IEEE Std 100 and IEC 63040-3.

1.4 SYSTEM DESCRIPTION

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Edit the following articles to match project requirements. NOTE: Delete system cabinet when specifying single module UPS.
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A. The double-conversion UPS shall consist of UPS module, battery system, battery protective device, system cabinet, static bypass transfer switch, external maintenance bypass, controls and monitoring. Input ac power shall be connected to the normal source ac input of the UPS module. The battery shall be connected to the dc input of the UPS module through the battery protective device. The ac output of the UPS shall be connected to the critical loads.

B. Performance Requirements

1. Normal Operation

a. The UPS module rectifier/charger shall convert the incoming ac input power to dc power for the inverter and for float charging the battery.

b. The inverter shall supply ac power continuously.

c. Inverter output shall be synchronized with the bypass ac power source, when the bypass ac power source is within the specified frequency range.

d. The UPS shall supply ac power to the critical loads.

2. Loss of ac Input Power

    a. The battery shall supply dc power to the inverter so that there is no interruption of ac power to the critical load whenever the ac input power source deviates from the specified tolerances or fails completely.

    b. The battery shall continue to supply power to the inverter for the specified protection time. At the same time, an alarm shall sound to alert operating personnel, allowing startup of a secondary power source or orderly shutdown of the critical load.

3. Return of ac Input Power Source

    a. The rectifier/charger shall start and assume the dc load from the battery when the ac input power source returns.

    b. The rectifier/charger shall then simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.

4. Failure of ac Input Power to Return

    a. Should the ac input power fail to return before the battery voltage reaches the discharge limit, the UPS shall disconnect from the critical load to safeguard the battery.

5. Failure of a Module

****
NOTE: Delete for parallel non-redundant multi-module UPS and single module UPS.
****

    a. In a redundant configuration, failure of one module shall cause that module to be disconnected from the system critical load bus by its internal protective devices and its individual output protective device.

    b. The remaining module shall continue to carry the load.

    c. Upon restoration of the failed module, it shall be possible to reconnect the failed module to the critical load bus to resume redundant operation without disruption of the critical load.

6. Transfer to Bypass AC Power Source

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NOTE: Edit as required for parallel non-redundant multi-module UPS or single module UPS.
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    a. When the static bypass switch senses an overload, two or more inverter shutdown signals, or degradation of the inverter output, the bypass switch shall automatically transfer the critical load from the inverter

output to the bypass ac power source without an interruption of power only if the connected load exceeds the capacity of the remaining on-line modules.

b. If the bypass AC power source is out of normal tolerance limits, the UPS and the critical load shall shut down.

7. Retransfer to Inverter

a. The static bypass switch shall be capable of automatically retransferring the load back to the inverter output after the inverter output has returned to normal conditions.

b. Retransfer shall not occur if the two sources are not synchronized.

****
NOTE: Delete for parallel non-redundant multi module UPS and single module UPS.
****

8. UPS modules shall be capable of manual disconnection from the critical load bus for maintenance without disturbing the critical load bus.

9. UPS Maintenance

a. Manual closure of the maintenance bypass switch shall transfer the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus.

b. UPS module shall be capable of manual return to normal operation after completion of maintenance.

10. Battery Maintenance

a. The battery protective device shall provide the means of disconnecting the battery from the rectifier/charger and inverter for maintenance.

b. The UPS module shall continue to function and meet the performance criteria specified except for the battery function.

1.5 QUALITY ASSURANCE

A. Provide products that are listed and labeled to the current edition of UL 1778, Uninterruptible Power Systems by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

B. Provide UPS(s) manufactured in a certified ISO 9001 or 9002 facility.

C. Comply with the National Electrical Code (NEC) for components and installation.

D. Comply with NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems, for components, installation, and testing.

E. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. IEC 62040, Uninterruptible Power Systems.

2. IEEE C57.110, Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents.

3. IEEE Std C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.

4. IEEE Std C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

5. IEEE Std C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.

6. IEEE Std 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

7. IEEE Std 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

8. IEEE 1184, Guide for Batteries for Uninterruptible Power Supply Systems.

9. NECA 1, Standard Practices for Good Workmanship in Electrical Construction (ANSI).

10. NEMA PE 1, Uninterruptible Power Systems—Specification and Performance Verification.

11. UL 1778, Uninterruptible Power Systems – Third Edition.

12. 47 CFR Ch. 1 Part 15, Subpart B – Unintentional Radiators.

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NOTE: Reliability and maintainability are relative terms, and the attainable level will, depend upon the type, size, configuration, and degree of redundancy of the UPS. System availability is a function of reliability and maintainability and is defined as the long-term average fraction of time that a system is satisfactorily in service. System availability should be as high as economically feasible and may be calculated as follows:

A = MTBF/(MTBF + MTTR)

Where

A = Availability

MTBF = Mean Time Between Failures

MTTR = Mean Time To Repair

Non-redundant systems can have a predicted MTBF of 20,000 hours and an actual MTBF of 40,000 hours. On the other hand, larger redundant systems or non-redundant systems with available utility power through a bypass arrangement can have an actual MTBF of 200,000 hours. A multi-module system with utility power bypass arrangement will have a higher MTBF than a single module system with the same rating.

The designer should give serious thought and consideration to the question of specifying MTBF and MTTR. For additional information on the subject refer to the following:

a. IEEE Std 446, Emergency and Standby Power Systems for Industrial and Commercial Applications.
b. IEEE Std 493, Design of Reliable Industrial and Commercial Power Systems.
c. MIL-STD 471, Maintainability Verification/ Demonstration/Evaluation.

Refer to LANL ESM Chapter 7, Section D5090 for UPS configuration requirements for critical loads such as Safety Class systems or critical telecommunications loads.

An 8-hour to 12-hour service technician on-site response time for most mid-level critical loads is an adequate standard. For high-end critical loads, the usual standard is 2 hours to 4 hours. Carefully evaluate cost/benefits ratio of requiring a short on-site response time, added redundancy may be a more cost-effective approach.
****

F. UPS shall have a minimum acceptable system Mean Time Between Failures (MTBF) of [_____] hours. A failure is defined as any interruption to or degradation of the UPS output. Automatic switching to bypass due to a problem with the UPS does not constitute a failure, provided that the critical load is not disturbed.

G. UPS shall have a maximum acceptable system Mean Time To Repair (MTTR) of [30] [_____] minutes. Repair time is defined as the clock time from the arrival of the service technician to the time when the UPS is restored to service either by repair or substitution of the failed component.

H. UPS manufacturer shall have spare parts and factory-trained service technicians located such that on-site response time will not exceed [12][8] hours, seven days per week.

1.6 RECEIVING, STORING AND PROTECTING

A. Receive, inspect, handle, and store UPS(s) according to the manufacturer's written instructions and NECA 1.

B. Protect equipment placed in storage from humidity and temperature variations, dirt, dust, or other contaminants.

1.7 EXTRA MATERIALS

A. Provide one spray can of touch-up paint that matches UPS finish.

B. Provide a spare set of three fuses of each type and size installed in each UPS.

C. Furnish one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

D. On-site spare parts/modules as required to meet specified MTTR requirements specified in QUALITY ASSURANCE.

1.8 SERVICE CONDITIONS

A. Provide UPS and accessories that will perform satisfactorily in any combination the following service conditions without mechanical or electrical damage or degradation of operating characteristics:

1. Operating elevation of 7500 feet above sea level.

2. Operating ambient temperature extremes of 32 to 104 degrees F.

3. 24-hour average operating ambient temperature not exceeding 86 °F.

4. Operating relative humidity: 0 to 95 percent, without condensation.

5. International Building Code seismic criteria:

a. Seismic Design Category = D

b. SDS = spectral acceleration, short period = 0.54g

c. a_p = component amplification factor = 1.0

d. R_p = component response modification factor = 2.5

e. I_p = Component importance factor
I_p = 1.5 for life safety related components such as emergency system UPSs
I_p = 1.5 for safety class or safety significant system UPSs.
I_p = 1.0 for all other UPS applications

B. Conform to NEMA PE 1 service conditions during and after installation of UPSs.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 2500, Substitution Procedures.

2.2 UPS GENERAL REQUIREMENTS

A. Provide NRTL-listed enclosed UPS that is designed and fabricated in accordance with NEMA PE 1 and has electrical ratings and configurations as indicated on Drawings or specified in this Section.

B. Provide UPS that meets FCC Class A requirements in accordance with 47 CFR Ch. 1 Part 15, Subpart B – Unintentional Radiators.

C. UPS Module and Battery System

1. UPS module shall contain required input isolation transformer, rectifier/charger unit, inverter unit and controls, battery protective device, and any other specified equipment/devices.

2. Battery system shall contain the battery cells, racks, battery disconnect, battery monitor and cabinet, if required.

D. The UPS shall include the system cabinet, static bypass transfer switch, system protective devices, monitoring and controls, means of isolating the system from the critical load, external maintenance/bypass switches, and remote monitoring interfaces.

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NOTE: Select UPS module sound pressure levels (at 1 meter) as follows:
UPS modules rated up to 125 kVA: 65 dB or lower.
UPS modules rated 130 up to 225 kVA: 67 dB or lower.
UPS modules rated 300 kVA and greater: 72 dB or lower.

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E. Sound pressure levels produced by the UPS, when operating under full rated load, at a distance of 1 meter in any direction from the perimeter of the unit, shall not exceed [65] [67][72] dB when measured in accordance with IEC 62040-3.

F. Design Requirements

1. Parts and materials comprising the UPS shall be new, of current manufacture, of a high grade and free of defects and imperfections, and shall not have been in prior service except as required during aging and factory testing.

2. Active electronic devices shall be solid state. Semiconductor devices shall be sealed. Relays shall be dust-tight.

3. Power semiconductors shall be fused to prevent cascaded or sequential semiconductor failures. Indicator lamp denoting blown fuse conditions shall be readily observable by the operator without removing panels or opening cabinet doors.

4. The subassemblies in one UPS module shall be interchangeable with the corresponding modules within the same UPS, and from one UPS to another of identical systems.

5. Control power shall be derived from two sources, input and output, with automatic selective control. The control power circuit shall have suitable protection, appropriately marked and located in the immediate vicinity of the input protective device.

6. The components and the system shall be designed to minimize the emission of electromagnetic waves that may cause interference with other equipment.

7. Wiring practices, materials, and coding shall be in accordance with the NEC and other applicable standards.

8. Terminal blocks shall be provided for field wiring terminals. Terminal blocks shall be heavy-duty, strap-screw type.

9. Subassemblies shall be mounted in pull-out and/or swing-out trays where feasible.

10. UPS shall be installed in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting.

    a. UPS module cabinet shall be structurally adequate for forklift handling or lifting.

    b. Removable lifting eyes shall be provided on top of each cabinet.

    c. UPS module cabinet shall have hinged and lockable doors on the front only, with assemblies and components accessible from the front. Doors shall be key lockable.

    d. Operating controls shall be located outside the locked doors.

    e. Input, output, and battery cables shall be installed through the top or bottom of the cabinet.

11. Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards.

12. If painted, mimic bus and other front-panel markings (such as those showing circuit breakers or switches and fuses) shall be painted with durable acrylic-based paint.

13. Live parts (300 volts and above) that are exposed when front access doors are open shall be adequately protected to minimize the chance of accidental contact.

14. Drawout assemblies weighing 50 lbs or more shall be provided with a means of lifting, either an overhead device or a hoisting device.

15. UPS shall be equipped with instruction plates including warnings and cautions, suitably located, describing any special or important procedures to be followed in operating and servicing the equipment.

2.3 LOAD PROFILE

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NOTE: Determine power factor requirements. Edit Table as required. The UPS capacity is specified in kW. kVA varies with power factor. A typical 60 kW UPS delivers 60 kW and 75 kVA at 0.8 power factor (lagging); 60 kW and 66.7 kVA at 0.9 power factor; and 60 kW and 60 kVA at 1.0 power factor. The UPS may exhibit load interface problems with certain types of ac load. The items which present the greatest problems are motors, transformers, electric discharge lighting, and SCR and mag-amp power supplies. Problems with these loads are caused by either load nonlinearity or inrush currents required for their operation. The Contractor will be better able to accommodate specific applications if well-defined load data is available. Factors to consider include:

a. Type of load - Data processing equipment, main frame chilled water pump, etc.

b. Size of load - kVA or kW rating, horsepower, voltage and amperage of load.

c. Switching pattern - Unswitched; cycled daily; cycled hourly; operated by thermostat; building management system control.

d. Transient characteristics - Specify inrush current magnitude and duration (i.e., 15 times steady state rms current for ¼ cycle for electric discharge lighting); range of power factor variation (i.e., as low as 0.4 lagging for electric discharge lighting); voltage dip.

e. Steady-state characteristics - specify range of power factor, particularly if outside the 0.8 lagging to 1.0 range. UPS derating is normally required for the unusual circumstance of loads at leading power factor. Consult vendors if in doubt. In some cases a demand factor might be applicable to the load.

f. Special factors - Harmonic characteristics; factors that vary with temperature or age. The designer may vary the load profile format. Estimated or approximated load data may be used in the absence of exact information but should be so identified.

The designer should carefully evaluate the UPS application to anticipate problems and to adjust the design accordingly. The problems associated with UPS/load interaction can be reduced by:

LARGE TRANSFORMER APPLICATION

a. Using a transformer specifically designed for the transient specifications of the UPS.

b. Using a UPS with operating characteristics that will not cause the transformer to saturate.

MOTOR APPLICATION

a. Using a UPS capable of providing motor inrush without current limiting.

b. Transferring the load bus to an alternate source to start the motor and retransferring to the UPS after the motor has started.

c. Oversizing the UPS so the motor load represents a small portion of the UPS capacity.

d. Using a UPS with a modified inverter filter that is compatible with synchronous motors.

OTHER NONLINEAR LOADS

a. Using a UPS with a modified inverter filter.

b. Oversizing the UPS.

c. Avoiding connection of electric discharge lighting to the UPS. Other emergency sources should be used for this lighting.

****

A. The UPS shall be compatible with the load characteristics defined in the LOAD PROFILE TABLE below and load configuration shown. Compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush shall be provided.

LOAD PROFILE TABLE

Type of load: [_____].

Size of load: [_____].

Switching pattern: [_____].

Transient characteristics: [_____].

Steady-state characteristics: [_____].

Special factors: [_____].

2.4 UPS RATINGS

A. Unless stated otherwise, the parameters listed are under full output load at 0.8 lagging power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

B. System Capacity

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NOTE: System capacity for single module UPS is same as module capacity. For multi-module UPS, select required redundancy. Parallel redundant UPS are usually N+1 redundant, where N is the number of modules needed to carry the full load.
****

1. Overall [_____] kVA, [_____] kW, [non] [N+1] [N+2] redundant, at 40 degrees C and 7500 ft elevation.

2. Module Capacity [_____] kVA, [_____] kW.

C. Battery Capacity

****
NOTE: Typical battery discharge times are 5, 10, 12, 15, and 30 minutes. If no emergency source is available, longer battery discharge time may be required.
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1. Discharge time to end voltage: Not less than [15] [_____] minutes, at 25 degrees C (77 degrees F). Battery shall be capable of delivering not less than 125 percent of full rated UPS load at initial start-up.

D. Static Switch

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NOTE: The interrupting capacity requirements must be determined for each project distribution system.
****

1. [_____] amperes, [_____] amperes symmetrical interrupting capacity.

E. System Bus Bracing

1. Braced for [_____] amperes symmetrical interrupting capacity.

F. AC Input

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NOTE: Total harmonic current distortion (THD) is usually specified as follows: modules 15-224 kVA 10 percent; modules above 225 kVA 5 percent. If UPS will be supplied from a generator, the generator capacity must be at least twice the UPS capacity if THD exceeds 5 percent.
****

1. Voltage [208] [480] volts line-to-line.

2. Number of phases: 3-phase, 3-wire, plus ground.

3. Voltage Range: Plus 10 percent, minus 15 percent, without affecting battery float voltage or output voltage.

4. Frequency: 60 Hz, plus or minus 5 percent.

5. Power walk-in: 20 percent to 100 percent over 15 to 24 seconds.

6. Total harmonic current distortion (THD) reflected into the primary line: 10 percent maximum.

7. Transformer sub-cycle inrush: 4 to 8 times full load rating.

G. AC Output

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NOTE: If the output voltage is 120/208 V and the same voltage is not available for the static bypass and maintenance bypass, a transformer will be required in the bypass distribution system. Delete load sharing and redundant module for single module systems.
****

1. Voltage [208] [480] volts line-to-line, [120] [277] volts line-to-neutral.

2. Number of phases: 3-phase, 4-wire, plus ground.

3. Voltage regulation:

   a. Balanced load: Plus or minus 1.0 percent.

   b. 50 percent load imbalance, phase-to-phase: Plus or minus 2 percent.

   c. No-load voltage modulation: Plus or minus 1 percent.

   d. Voltage drift: Plus or minus 1 percent over any 30 day interval (or length of test) at stated ambient conditions.

4. Voltage adjustment: Plus or minus 5 percent manually.

5. Frequency: 60 Hz.

6. Frequency regulation: Plus or minus 0.1 percent.

7. Frequency drift: Plus or minus 0.1 percent over any 24 hour interval (or length of test) at stated ambient conditions when on internal oscillator.

8. Harmonic content (RMS voltage): 3 percent single harmonic, maximum; 5 percent total maximum with linear load. Voltage THD shall be less than 7 percent with up to 50 percent nonlinear load and a crest factor of less than 3 to 1.

9. Load power factor operating range: 1.0 to 0.8 lagging.

10. Phase displacement:

    a. Balanced load: Plus or minus 1 degree of bypass input.

b. 50 percent load imbalance phase-to-phase: Plus or minus 3 degrees of bypass input.

11. Wave-form deviation factor: 5 percent at no load.

12. Overload capability (at full voltage) (excluding battery):

a. 125 percent load for 10 minutes.

b. 150 percent load for 30 seconds.

c. 300 percent load for one cycle after which it shall be current limited to 150 percent until fault is cleared or UPS goes to bypass.

****
Delete load sharing and redundant module for single module systems.
****

13. Load sharing of parallel and redundant modules: Plus or minus 5 percent of average load per module.

H. Transient Response

1. Voltage Transients

a. 50 percent load step/0 percent to 50 percent load: Plus or minus 8 percent.

b. 50 percent load step/50 percent to 100 percent load: Plus or minus 8 percent.

c. Loss or return of ac input: Plus or minus 1 percent.

d. Loss or return of redundant module: Plus or minus 8 percent.

e. Automatic transfer of load from UPS to bypass: Plus or minus 4 percent.

f. Manual retransfer of load from bypass to UPS: Plus or minus 4 percent.

g. Response time: Recovery to 99 percent steady-state condition within 50 milliseconds after any of the above transients.

2. Frequency

a. Transients: Plus or minus 0.5 Hz maximum.

b. Slew Rate: 1.0 Hz maximum per second.

I. Efficiency

****
NOTE: Specify minimum system efficiencies at full load are as follows:

UPS capacity	208 Volts (single module)	480 Volts (single module)	480 Volts (multi-module)
15 kVA to 50 kVA	88 Percent	90 Percent	---
65 kVA to 225 kVA	90 Percent	92 Percent	90 Percent
Above 225 kVA	---	92 Percent	90 Percent

****

1. Minimum Single-Module Efficiency: [88] [90] [92] percent at full load kW.

****
Delete system efficiency requirements for single module UPS.
****

2. Minimum Multi-Module System Efficiency: 90 percent at full system load kW.

2.5 UPS MODULE

A. UPS module shall consist of a rectifier/charger unit and a 3-phase inverter unit with their associated transformers, synchronizing equipment, protective devices and accessories as required for operation.

B. Rectifier/Charger

1. Unit Rectifier/charger unit shall be solid state and shall provide direct current to the dc bus.

2. Input Protective Device

a. Rectifier/charger unit shall be provided with an input protective device.

b. The protective device shall be sized to accept simultaneously the full-rated load and the battery recharge current.

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Edit the following article to indicate the available short circuit current at the UPS connection point.
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c. The protective device shall be capable of shunt tripping and shall have [_____] amperes symmetrical interrupting capacity.

d. The protective device shall have provision for locking in the “off” position.

e. A surge suppression device selected in accordance with IEEE C62.41.1 shall be installed at the UPS input to protect against lightning and switching surges.

3. Input Isolation Transformer

a. Provide an all copper winding, dry-type, isolated-winding power transformer selected in accordance with IEEE C57.110 at the input to the rectifier unit.

b. The transformer's hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation material when operating at full load with a non-linear 6-pulse rectifier.

c. The transformer insulation shall be Class H, 150 degrees C rise. Transformer connections shall be accessible from the front.

4. Input Filter

a. The rectifier/charger shall include an input filter to reduce reflected input current distortion to 10% THD at full load with nominal input voltage.

b. The input filter shall maintain the input power factor at 0.90-0.96 lagging minimum from full load to half load with nominal input voltage.

5. Power Walk-In

a. Rectifier/charger unit shall be protected by a power walk-in feature such that when ac power is returned to the ac input bus, the total initial power requirement will not exceed 20 percent of the rated full load current.

b. This demand shall increase gradually to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

6. Rectifier/charger unit shall be sized for the following two simultaneous operating conditions:

a. Supplying the full rated load current to the inverter.

b. Recharging a fully-discharged battery to 95 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored, with the input protective device closed.

7. Battery Charging Current

****

NOTE: Delete second step current limiting if the UPS will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the recharge current of the battery.

****

a. Primary current limiting: Battery-charging current shall be voltage regulated and current limited. The battery-charging current limit shall be separately adjustable from 2 percent to 25 percent of the maximum discharge current. After the battery is recharged, the rectifier/charger

unit shall maintain the battery at full float charge until the next operation under input power failure. Battery charger shall be capable of providing equalizing charge to the battery.

b. Second step current limiting: The rectifier/charger unit shall also have a second-step battery current limit. This second-step current limit shall sense actual battery current and reduce the input power demand for battery recharging to 50 percent (adjustable from 30 percent to 70 percent) of the normal rate without affecting the system's ability to supply full-rated power to the connected load. The second-step current-limit circuit shall be activated by a dry contact signal from the generator set controls and shall prevent normal rate battery recharging until utility power is restored.

8. Rectifier/charger unit shall have an output filter to minimize ripple current supplied to the battery; the ripple current into the battery shall not exceed 3 percent RMS.

9. Rectifier/charger unit shall have manual means for adjusting dc voltage for battery equalization, to provide voltage within plus 10 percent of nominal float voltage.

10. Module shall have a dc circuit breaker to isolate the module from the battery system.

a. The circuit breaker size and interrupting rating shall be as required by system capacity.

b. Battery circuit breaker shall incorporate a shunt trip or under-voltage release and auxiliary contacts as required by circuit design.

c. The protective device shall have provision for locking in the "off" position.

C. Inverter Unit

1. Inverter unit shall be a solid-state device capable of accepting power from the dc bus and providing ac power within specified limits.

2. The inverter shall be able to sustain an overload as specified across its output terminals. The inverter shall not shut off, but shall continue to operate within rated parameters, with inverse-time overload shutdown protection.

3. The inverter shall normally operate in phase-lock and synchronism with the bypass source.

a. Should the bypass source frequency deviate beyond 60 Hz by more than 0.5 Hz, the internal frequency oscillators contained in the power module shall be used to derive the new frequency reference.

b. Upon restoration of the bypass source within the required tolerance, the inverter shall resynchronize with that source at a slew rate not exceeding the specified rate.

c. The oscillator shall be temperature compensated and shall be manually adjustable.

d. The design of the oscillator and synchronizing circuits shall be such that failure of any associated component, connector pin, terminal lead wire or dc power source in either the open or shorted mode shall affect only one inverter leg. Such failure shall not cause transient disturbance of the critical load in excess of the stated limits.

4. Electronic controls shall be incorporated to provide individual phase voltage compensation to obtain phase balance.

5. Each control logic printed circuit board shall be electrically and physically packaged on an individual plug-in module with separate indication and adjustments.

6. The output protective device shall be capable of shunt tripping and shall have interrupting capacity as specified. Protective device shall have provision for locking in the “off” position.

7. The inverter output transformer shall be similar to the input transformer and shall be capable of handling up to [K-13] [_____] nonlinear loads as described in IEEE C57.110.

****
NOTE: Delete for single module UPS.
****

8. Each inverter in the UPS shall have fault sensing and static isolation as well as an output protective device, to remove a faulted module from the system without affecting the critical load bus beyond the stated limits.

D. UPS module shall have built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source.

1. The UPS shall sustain input surges without damage in accordance with IEEE C62.41.1.

2. The UPS shall also have built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.

E. UPS module shall be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals.

1. UPS module shall be provided with output reverse power detection which shall cause that module to be disconnected from the critical load bus when output reverse power is present.

2. UPS module shall have built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load.

3. At the end of battery discharge limit, the module shall shut down without damage to internal components.

****
NOTE: Delete for single module UPS.
****

F. For parallel operation, the protection system shall have control logic capable of isolating only the faulted module, and shall not shut down the entire UPS upon a fault in one module. Open protective devices shall be indicated by an alarm and indicator light.

2.6 STATIC BYPASS TRANSFER SWITCH

A. Provide a static bypass transfer switch as an integral part of the UPS, consisting of a static switch and a bypass protective device or bypass switch. The control logic shall contain an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the bypass ac power source, without exceeding the transient limits specified herein, when a malfunction occurs in the UPS or when an external overload condition occurs. The power section of the static bypass transfer switch shall be provided as a plug-in type assembly to facilitate maintenance. The static bypass transfer switch shall be used to connect the bypass ac power source or the UPS inverter output to the critical load when required, and shall have the following features:

B. Uninterrupted Transfer

1. The static bypass transfer switch shall automatically cause the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:

a. Inverter overload exceeds unit’s rating.

b. Battery protection period is expired and bypass is available.

c. Inverter failure.

C. Interrupted Transfer

1. If an overload occurs and the UPS inverter output is not synchronized to the bypass ac power source, the UPS inverter output shall current-limit for 200 milliseconds minimum. The inverter shall then turn off and an interrupted transfer to the bypass ac power source shall be made. If the bypass ac power source is beyond the conditions stated below, an interrupted transfer shall be made upon detection of a fault condition:

   a. Bypass voltage greater than plus or minus 10 percent from the UPS rated output voltage.

   b. Bypass frequency greater than plus or minus 0.5 Hz from the UPS rated output frequency.

   c. Phase differential of ac bypass voltage to UPS output voltage greater than plus or minus 3 degrees.

D. It shall be possible to make a manually-initiated static transfer from the system status and control panel by turning the UPS inverter off.

E. The static bypass transfer switch shall automatically forward transfer, without interruption after the UPS inverter is turned “on”, or after an instantaneous overload-induced reverse transfer has occurred and the load current has returned to less than the unit’s 100 percent rating.

F. The control logic circuitry shall provide the means of making a forced or reverse transfer of the static bypass transfer switch on an interrupted basis. Minimum interruption shall be 200 milliseconds when the UPS inverter is not synchronized to the bypass ac power source.

G. The static bypass transfer switch shall withstand the following overload conditions:

1. 2000 percent of UPS output rating for two cycles.

2. 200 percent of UPS output rating for 5 minutes.

3. 125 percent of UPS output rating for 10 minutes.

****
NOTE: Delete if the static switch is of the draw-out type.
****

H. A static switch disconnect shall be incorporated to isolate the static bypass transfer switch assembly so it can be removed for servicing. The switch shall be equipped with auxiliary contacts and provision for padlocking in either the “on” or “off” position.

2.7 MAINTENANCE BYPASS SWITCH

****
NOTE: Delete for multi-module UPS. For multi-module UPS a UPS maintenance bypass should be incorporated into the UPS output switchgear.
****

A. Provide a matching external maintenance bypass cabinet or switchboard to enable the UPS module to be completely isolated from the electrical system while the critical load is powered through the external maintenance bypass line.

1. The maintenance bypass cabinet shall provide the capability to continuously support the critical load from the bypass ac power source while the UPS is isolated for maintenance.

2. Maintenance bypass shall include a normally-closed UPS bypass line circuit breaker, normally-open maintenance bypass circuit breaker, and normally-closed UPS output circuit breaker, all interlocked to assure proper and safe sequence of operation, plus necessary auxiliary contacts, inter-cabinet wiring.

B. The maintenance bypass switch shall provide the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.

C. Provide a load bank protective device to allow the UPS to be tested using a portable load bank. The load bank protective device shall be connected on the line side of the maintenance bypass switch isolation protective device.

2.8 MODULE CONTROL PANEL

A. Provide the UPS module with a control/indicator panel. The panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel.

B. The following functions shall be monitored and displayed:

****
NOTE: Delete bypass voltage, output kilovars and output kWh for multi-module systems. These meters will be on the system control cabinet.
****

1. Input voltage, phase-to-phase (all three phases).

2. Input current, all three phases.

3. Input frequency.

4. Battery voltage.

5. Battery current (charge/discharge).

6. Output voltage, phase-to-phase and phase-to-neutral (all three phases).

7. Output current, all three phases.

8. Output frequency.

9. Output kilowatts.

10. Elapsed time meter to indicate hours of operation, 6 digits.

11. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).

12. Output kilovars.

13. Output kilowatt hours, with 15-minute demand attachment.

C. Meters shall have 1 percent accuracy and shall be digital type (minimum 4 significant digits).

****

NOTE: Delete transfer switch references for multi-module systems. These controls will be on the system control cabinet.

****

D. Module shall have the following controls:

1. Lamp test/reset pushbutton.

2. Alarm test/reset pushbutton.

3. Module input protective device trip pushbutton, with guard.

4. Module output protective device trip pushbutton, with guard.

5. Battery protective device trip pushbutton, with guard.

6. Emergency off pushbutton, with guard.

7. dc voltage adjustment potentiometer, with locking guard.

8. Control power off switch.

9. UPS/bypass transfer selector switch.

10. Static bypass transfer switch enable/disable selector switch.

****

NOTE: Delete last 12 items for multi-module UPS. These alarms will be on the system control cabinet.

****

E. Module shall have indicators for the following alarm items. Any one of these conditions shall turn on an audible alarm and the appropriate summary indicator. Each new alarm shall register without affecting any previous alarm.

1. Input ac power source failure.
2. Input protective device open.
3. Output protective device open.
4. Overload.
5. Overload shutdown.
6. dc overvoltage.
7. dc ground fault.
8. Low battery.
9. Battery discharged.
10. Battery protective device open.
11. Blower failure.
12. Input transformer overtemperature.
13. Inverter transformer overtemperature.
14. Equipment overtemperature.
15. Operating on internal oscillator.
16. Fuse blown.
17. Control power failure.
18. Charger off.
19. Inverter off.
20. Emergency off.
21. UPS on battery.
22. Critical load on static bypass.

23. Static bypass transfer switch disabled.

24. Inverter output overvoltage.

25. Inverter output undervoltage.

26. Inverter output overfrequency.

27. Inverter output underfrequency.

28. Bypass source overvoltage.

29. Bypass source undervoltage.

30. Bypass source overfrequency.

31. Bypass source underfrequency.

32. Bypass source to inverter out of synchronization.

****

NOTE: Delete the requirement for the four additional functions for multi-module UPS. These indicators will be on the system control cabinet.

****

F. UPS module shall have a mimic panel in the format of a module single-line diagram, with status indicators for input, output, battery protective devices, and battery disconnect switch. Each protective device shall have indicators for open (green) and closed (red), to give positive indication. The mimic panel shall provide indication of the following additional functions:

1. Charger on (functional).

2. UPS on-line (inverter furnishing load power).

3. UPS on-bypass (static switch operating).

4. System alarm (flashes for abnormalities, minor or major faults).

G. Pressing the emergency off button shall cause the affected module to be disconnected from the system, via its input protective device, output protective device, and battery protective device. Activation of this button shall not affect the operation of the remainder of the system.

2.9 SYSTEM CONTROL CABINET

****

NOTE: Delete for single module UPS.

****

A. Provide the multi-module UPS with a separate control cabinet for system output, summary monitoring, and control. This unit shall contain; bus bar connections to collect the output from each module, the static switch and its bypass breaker, the UPS output protective device, and the UPS output switchgear.

B. The UPS output switchgear shall consist of a main protective device feeding the UPS output switchgear critical load bus, a load bank protective device (connected on the line side of the main protective device), a maintenance bypass protective device and associated feeder protective devices for the critical loads.

1. The main protective device and the load bank protective device shall be interlocked to prevent both being closed at the same time. The maintenance bypass protective device shall be interlocked with the UPS output protective device and the static bypass switch. The maintenance bypass protective device shall not be capable of closing until the static bypass switch is closed and the UPS output protective device is open. Once the maintenance bypass protective device is closed, the UPS output switchgear main protective device shall be capable of opening to isolate the critical loads from the UPS output. The load bank protective device as well as the UPS output protective device shall then be capable of closing to permit load bank testing.

2. UPS output switchgear shall be provided in accordance with Section 26 2413, Switchboards.

C. A separate control panel shall be provided for the overall UPS. The panel shall be on the front surface of the system cabinet. The controls, meters, alarms and indicators for operation of the UPS shall be on this panel.

1. Meters shall have 1 percent accuracy and shall be digital type (minimum 4 significant digits). ac voltages shall be measured as true RMS voltages. The following functions shall be monitored:

****
NOTE: Delete maintenance bypass metering functions if there is no maintenance bypass.
****

a. Output voltage, phase-to-phase and phase-to-ground (all three phases).

b. Output current, all three phases.

c. Output frequency.

d. Bypass voltage, phase-to-phase and phase-to-ground (all three phases).

e. Output kilowatts.

f. Output kilovars.

g. Output kVA.

h. Output kilowatt-hours, with demand attachment.

i. Maintenance bypass voltage, phase-to-phase and phase-to-ground (all three phases).

2. The system cabinet shall include the following controls:

a. Lamp test/reset.

b. Alarm test/reset.

c. Voltage adjustment potentiometer.

d. Emergency off pushbutton with protective cover.

e. UPS/bypass transfer selector switch.

f. Static switch enable/disable selector switch.

g. Control power off switch.

3. The system control panel shall contain indicators for the following additional alarm items. Any one of these alarm conditions shall also activate the audible alarm. Each new alarm shall register without affecting previous alarms.

a. Module summary alarm, one for each UPS module.

b. UPS on battery.

c. Low battery voltage.

d. Critical load on bypass.

e. Static switch disable.

f. Output overvoltage.

g. Output undervoltage.

h. Output overfrequency.

i. Output underfrequency.

j. Overload.

k. Bypass source overvoltage.

l. Bypass source undervoltage.

m. Bypass source overfrequency.

n. Bypass source underfrequency.

o. Bypass source to inverter out of synchronization.

p. Equipment overtemperature.

q. Control power failure.

4. The system control panel shall contain a mimic panel in the format of a single-line diagram, with status indicators for the following items:

a. Module on-line, one per UPS module.

b. UPS output protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).

c. Static bypass protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).

d. Static switch status, one for connected (red), and one for disconnected (green).

5. Pressing the emergency off button shall cause the module input, output, and battery circuit breakers to open, completely isolating the UPS from sources of power. The critical load shall be transferred to the bypass source when this occurs.

2.10 REMOTE MONITORING PANEL

****
NOTE: Delete if a remote monitoring panel is not required.
****

A. Provide a remote monitoring panel to monitor system status. The panel shall be designed for wall mounting near the critical load.

1. Minimum display shall include the following indicators:

a. Load on UPS.

b. Load on battery.

c. Load on bypass.

d. Low battery.

e. Summary alarm.

f. New alarm (to alert the operator that a second summary alarm condition has occurred).

****
NOTE: Delete system cabinet reference for single-module UPS.
****

B. Any single indicator shall also turn on the audible alarm. An audible alarm test/reset button and lamp test/reset button shall be included. This reset button shall not affect nor reset the alarm on the module or on the system cabinet.

2.11 COMMUNICATIONS

A. Provide an internal Simple Network Management Protocol (SNMP) adapter, which will connect the UPS directly to any I.P. based network using Ethernet communications.

1. The UPS will be a managed device on the network. From a network management station the system administrator shall be capable of monitoring important system measurements, alarm status and alarm history data.

2. In the event of a utility failure the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down due to low battery. On restoration of utility power the SNMP shall automatically resume full SNMP communication.

2.12 TEMPERATURE CONTROL

A. Cabinet and enclosure ventilation shall be adequate to ensure that components are operated within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. The cooling fans shall continue operation if UPS input power is lost. Redundancy shall be provided so that failure of one fan or associated circuit breaker will not cause an overheat condition. Cooling air shall enter the lower front of the cabinets and exhaust at the top. Blower power failure shall be indicated as a visual and audible alarm on the control panel. Air inlets shall have filters that can be replaced without opening the cabinet doors.

B. Blower power source shall be internally derived from the input and output sides of UPS module, with automatic transfer arrangement.

C. Temperature sensors shall be provided to monitor the air temperature. Separate sensors shall monitor the temperature of rectifier and inverter heat sinks. Separate sensors shall also monitor the transformer temperature. Critical equipment overtemperature indication shall start a timer that shall shut down the UPS if the temperature does not return below the setpoint level in [_____] minutes.

2.13 BATTERY SYSTEM

A. For each UPS module, provide a storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration. The battery shall be of heavy-duty, industrial design suitable for UPS service. Provide the cells with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Intercell connectors shall be sized to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Cell and connector hardware shall be stainless steel of a type capable of resisting corrosion from the electrolyte used.

B. Battery Ratings

1. Type: lead calcium.

2. Specific gravity when fully charged: 1.215.

3. End voltage 1.67 volts per cell.

4. Float voltage: 2.17 to 2.26 volts per cell.

5. Equalizing voltage: 2.33 to 2.38 volts per cell.

****
NOTE: Select battery type based on the LANL Engineering Standards Manual, Chapter 7, Section D5090.
****

C. The battery shall be of the [valve-regulated, sealed, non-gassing, recombinant type] [wet-cell type and shall be supplied complete with thermometer and hydrometer holder].

****
NOTE: Delete if a battery cabinet is not required.
****

D. Furnish the battery pack assembly in a battery cabinet matching the UPS cabinet. The battery cabinet shall be designed to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. External wiring interface shall be through the bottom or top of the assembly.

****
NOTE: Delete if a battery rack is not required. Three tier racks should be used only where floor space is limited. They increase floor loading and make maintenance more difficult.
****

E. Provide the battery with a suitable number of [two-tier] [three-tier] racks to fit the room layout. Battery rack shall be steel and shall be protected with electrolyte-resistant paint. Battery rack shall be shipped unassembled and shall include hardware necessary for assembly. Each rack shall be complete with bus bars to

accommodate cables from UPS module. Bus bar connectors for battery-to-battery connections and high-flex multi-stranded copper cable (ASTM B 173 stranding class H) with proper cable supports for connecting top row of batteries to bottom row of batteries at rack ends shall be provided. End sections shall be cut to length to prevent wasting floor space.

F. Provide acid-resistant transparent cell-terminal covers not exceeding 6 feet in length and with vent holes drilled on top where needed.

G. For each battery pack assembly provide a heavy-duty fused disconnect switch in a NEMA 4X enclosure and located in line with the battery pack assembly. Switch shall be complete with line side and load side bus bars for connection to battery cells. Switch shall be rated as required by system capacity, and shall have an external operator that is lockable in the “off” position.

****

NOTE: Provide seismic requirements for battery supports, if a LANL designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phase. Sections 13 4800, Sound, Vibration and Seismic Control and 26 0529, Hangers and Supports for Electrical Systems, properly edited, must be included in the contract documents.

****

H. The battery support system shall conform to Sections 13 4800, Sound, Vibration, and Seismic Control, and 26 0529, Hangers and Supports for Electrical Systems.

I. Battery Monitor

1. Provide a battery monitor for each battery pack assembly. At a minimum, this device shall monitor the following parameters:

a. Total system voltage.

b. Ambient room temperature.

c. Total battery discharge cycles with a duration of [30 seconds or less] [greater than 30 seconds but less than 5 minutes] [greater than 5 minutes].

2. The monitor shall also record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

2.14 FACTORY TESTING

****

NOTE: Edit as required for single module system. The designer should carefully evaluate the UPS application and the user’s mission to determine critical tests for the UPS that will ensure UPS/load compatibility. These tests should be conducted at the factory and the results validated prior to shipment to the site. The required UPS/load interaction can be achieved by requesting the following tests plus any other tests the designer deems necessary:
a. Tests to ensure that the UPS rated power factor is verified;
b. Tests to ensure that the UPS system will operate in total accord and support the rated load;

c. Tests to ensure that the UPS can deal with load anomalies (odd harmonics, etc.) associated with the user's equipment load.

****

A. Factory test the UPS to meet the requirements specified using a test battery (not the battery to be supplied with the system).

1. Load test each UPS module as an independent assembly with 3-phase ac input power and with battery power for a minimum of 8 hours, with meter readings taken every 30 minutes.

2. Load shall be balanced at rated kVA and rated power factor.

3. Factory tests for the UPS module shall be run under full load, and will be witnessed by the Contract Administrator or designated representative. Should a malfunction occur, the problem shall be corrected and the test shall be repeated. As a minimum, the factory tests shall include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. The tests shall encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings. The Contract Administrator shall be notified in writing at least 2 weeks before testing. Factory-test time shall not be used for system debugging and/or checkout. Such work shall be done prior to notifying the Contract Administrator that the system is ready for testing. Factory tests shall be performed during normal business hours. The system shall be interconnected and tested for an additional 8 hours to ensure proper wiring and performance.

B. Transient tests shall be conducted using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Contract Administrator. These tests shall include 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. A recording instrument equipped with an event marker shall be used.

C. Testing for efficiency shall be performed at zero output up to 100 percent of stated kVA output in 25 percent steps, 0.8 power factor, with battery fully charged and floating on the dc bus, with nominal input voltage, and with modules connected to the system to represent actual operating conditions.

****

NOTE: Delete the following article if witnessing of factory tests is not required. Witnessing of tests may be warranted for a large UPS or a UPS that serves safety systems. Consult with User and LANL Project Engineer.

****

D. [Factory tests will be witnessed by the LANL Contract Administrator's designated representative.]

****
NOTE: Delete the following article if factory inspection is not required. Inspection may be warranted for a UPS that is directly purchased by LANL. If the Contractor furnishes the UPS, factory inspection by LANL personnel may not be warranted. Consult with User and LANL Project Engineer.
****

2.15 INSPECTION

A. Inspection before shipment is required. The manufacturer shall notify the Contract Administrator at least 2 weeks before shipping date so that an inspection can be made.

2.16 SURGE PROTECTION

A. Provide transient voltage surge suppressors on the load side of each upstream circuit breaker supplying ac power to the UPS rectifier and bypass input terminals in accordance with NFPA 111; refer to Section 26 4123, Lightning Protection Surge Arresters ns Suppressors and 26 4313, Transient Voltage Suppressors.

2.17 UPS MANUFACTURERS

A. Eaton “Powerware”

B. General Electric “Digital Energy SG Series”

C. Liebert “NPOWER” or “Series 610”

PART 3 EXECUTION

3.1 EXISTING WORK

****
Delete this article when existing construction is not affected.
****

A. Disconnect and remove each abandoned UPS.

B. Maintain access to each existing UPS that is to remain active.

C. Clean and repair each existing UPS that is to remain or be reinstalled.

3.2 EXAMINATION

A. Examine spaces and surfaces to receive UPS for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install UPS where indicated on the Drawings and according to the approved shop drawings, the manufacturer's instructions, NFPA 111, and the NEC. Have the manufacturer's installation instructions available at the construction site.

B. Provide supports and seismic anchorage in accordance with the manufacturer's installation instructions and requirements of Section 26 0529, Hangers and Supports for Electrical Systems..

C. Ground and bond UPS as required in Section 26 0526, Grounding and Bonding for Electrical Systems.

D. Install conduits as required in Section 26 0533, Raceways and Boxes for Electrical Systems.

1. Terminate conduits in the UPS section containing the corresponding device.

2. Install plugged couplings set flush with the top of the concrete pad. After UPS is set in place, extend conduits to 1-1/4 inch above the pad and terminate with insulated grounding bushings.

E. Install conductors as required in Section 26 0519, Low Voltage Electrical Power Conductors and Cables.

1. Train conductors neatly in groups; bundle and secure as recommended by manufacturer to withstand fault current.

2. Use compression type lugs to connect all service, feeder, and branch circuit cables greater than 100 amperes.

3. Tighten electrical connectors and terminals, including bus bar and grounding connections, according to the manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.4 IDENTIFICATION

A. Identify UPS and install warning signs and arc-flash warning labels as required in Section 26 0553 Identification for Electrical Systems.

B. Provide engraved laminated Category I nameplate for each externally operable disconnect or overcurrent protective device. Refer to Section 26 0553, Identification for Electrical Systems.

C. Mark floor in front of UPS to show working space according to Section 26 0553, Identification for Electrical Systems.

D. Provide safety signs and labels inside and immediately outside the battery room or area prohibiting smoking, sparks, or flame.

E. Post one-line diagrams data and operating instructions in accordance with Section 26 0553, Identification for Electrical Systems.

3.5 FIELD QUALITY CONTROL

A. Clean, inspect, test, and energize installed UPS in accordance with the manufacturer's instructions.

B. Verify proper torque of accessible bus connections and mechanical fasteners after installing UPS.

C. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

D. Perform acceptance inspection and tests as required by NFPA 111 and Section 26 0813, Electrical Acceptance Testing.

3.6 MANUFACTURER'S FIELD SERVICE

A. Provide the services of a factory trained representative from the manufacturer who is experienced in the installation, adjustment, and operation of the equipment specified to inspect and certify the installation and to oversee energizing and testing.

B. The representative shall supervise the installation, adjustment and testing of the equipment. The representative shall check the wiring between equipment, start up the system, and field test the functions, interlocks and protective devices to ensure that the total system is functioning according to the intent of the design. The field tests shall be performed under the supervision of a factory-trained representative of the equipment manufacturer and witnessed by the Contract Administrator or designated representative. The Contract Administrator shall be given 2 weeks written advance notice of the date and time when testing will be conducted.

C. Field Tests

1. As a minimum, the startup and field test procedures shall include the following:

a. Ensure that shipping members have been removed.

b. Check for damage (dents, scratches, frame misalignment, damage to panel devices, etc).

c. Ensure that interiors are free of foreign materials, tools and dirt.

d. Verify that installation is in accordance with Contract Documents and approved submittals.

e. Verify neutral and ground conductors are properly sized and configured

f. Inspect battery cases

g. Verify all printed circuit boards are configured properly

h. Torque test bus connections at shipping splits. Also torque test battery connections.

i. Check all terminal screws, nuts, and/or spade lugs for tightness

j. Check all fuses for continuity

k. Confirm input voltage and phase rotation is correct

l. Verify control transformer connections are correct for voltages being used

m. Assure connection and voltage of the battery string(s)

n. Check each electrical bus for proper phasing and identification.

o. Check and test selector switches and meters for proper operation.

p. Check doors for proper alignment and operation.

q. Check and test each protective device for proper mechanical and electrical operation.

r. Check protective device overcurrent trip settings.

s. Check and test indicating lights for proper operation and color.

t. Perform onsite field test procedures.

u. Demonstrate to the LANL Contract Administrator that the specified functions and interlocks have been implemented.

v. Provide IEEE Std 450 battery installation certification.

w. Check key interlock key numbers, if used, to ensure agreement with interlocking scheme.

D. Load Test

****

NOTE: Edit as required, depending upon whether a temporary or permanent load bank is to be provided and on the type of UPS.

****

1. Load test the installed system for a continuous 24 hour period by means of resistive load banks. The system shall be continuously tested at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. [Load banks will be available onsite and shall be connected to UPS equipment by the Contractor.] [The equipment manufacturer shall provide resistive load banks of total kW load of equipment to facilitate startup under load conditions, and to conduct load tests described above.]

2. Record instrument readings every half hour for the following:

   a. Input voltage (all three phases, for each module).

   b. Input current (all three phases, for each module).

   c. Input frequency.

   d. Battery voltage for each module.

   e. Output voltage (all three phases, for each module).

   f. Output current (all three phases, for each module).

   g. Output kilowatts for each module.

   h. Output frequency.

   i. Output voltage (all three phases - system output).

   j. Output current (all three phases - system output).

   k. Output kilowatts (system output).

E. Full Load Burn In Test

****

NOTE: Delete emergency source testing requirements if no emergency source is available.

****

1. The installed system shall undergo an additional full load burn-in period of 24 continuous hours. If a failure occurs during the burn-in period, repeat the tests. Record instrument readings every half hour as above. During the burn-in period, perform the following tests:

a. With the UPS carrying maximum continuous design load and supplied from the normal source, switch [100 percent load] [50 percent load] on and off a minimum of five times within [the burn-in period] [_____].

b. With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching operations described in step a. Also, verify that the UPS module rectifier charger unit(s) go into the second-step current limit mode.

c. With the UPS carrying maximum continuous design load and operating on battery power, repeat the switching operations described in step a above.

d. Continue operation on battery power for 1 minute, then restore normal power.

2. Furnish a high-speed dual trace oscillograph to monitor ten or more cycles of the above tests at the ON and OFF transitions and two typical steady-state periods, one shortly after the load is energized (at 30 to 60 seconds) and one after operation has stabilized (at 8 to 10 minutes). Deliver four copies of the traces to the Contract Administrator.

F. Battery Discharge Test

****
NOTE: Delete module references if not needed.
****

1. With the battery fully charged, perform a complete battery discharge test to full depletion and a recharge to nominal conditions.

2. Record instrument readings every minute during discharge for the following:

a. Battery voltage for each module.

b. Battery current for each module.

c. Output voltage (all three phases) for each module.

d. Output current (all three phases) for each module.

e. Output kilowatts for each module.

f. Output voltage (all three phases - system output).

g. Output current (all three phases - system output).

h. Output kilowatts (system output).

i. Output frequency.

3.7 FIELD TRAINING

****

NOTE: Delete video tape references if not required; consider requiring video-taping of training for UPS systems rated 100 kVA or more.

****

A. Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of 12 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Cover the items contained in the operating and maintenance manuals. Divide the 12 hours into two sessions of 6 hours each. Conduct each session on a different day. [Videotape the field training and leave the tape with the Contract Administrator.] [Provide a factory training videotape as part of the training materials.]

END OF SECTION

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Do not delete the following reference information.

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FOR LANL USE ONLY

This project specification is based on LANL Master Specification 26 3353 Rev. 0, dated January 6, 2006.